

The Influence Of The Shallow Water Internal Tide On The Properties Of Acoustic Signals

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LONG-TERM GOAL

Quantitatively relate the temporal and spatial properties of shallow water acoustic signals to the physical processes that cause variability in the shallow water sound speed field. Address tides, internal tides, internal waves, fine structure, surface gravity wavefields and the heterogeneous ocean bottom/subbottom. Establish the relationship between signal variability and coherent processor gain.

SCIENTIFIC OBJECTIVES

Increase the understanding of the physics of broadband acoustic signal propagation through the random shallow water waveguide. Develop an ability to predict or estimate the coherence properties of acoustic signals propagating in shallow water.

APPROACH

Simultaneous measurement of the spatial and temporal properties of acoustic signals and the sound speed field as perturbed by a variety of flow induced fluid processes. Numerical simulation of the hydrodynamic perturbation of the sound speed field and the acoustic signals that propagate through it. The FY03 year was devoted to the continued analysis of the ONR FY01 AsiaEx South China Sea Ocean Research III environmental data and preparation for an FY04 experiment on the New Jersey Shelf titled "The Relationship of Acoustic Array Gain to Shelf Break Fluid Processes".

WORK COMPLETED

ASIAEX (South China Sea)

Vertical Array

In the ASIAEX-01 experiment, internal solitons entering an 18 km along shelf acoustic propagation path were found to be the direct cause of an order-of-magnitude drop (15 min to 2 min) in the matched-field auto-correlation time for 300 Hz and 500 Hz center band signal's received by a vertical line array. Sixteen days of vertical line data were analyzed.

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Horizontal Line Array

The AsiaEx 32 channel horizontal line was navigated (S. Wolf) and a conventional beamformer was applied to 29 channels of data acquired with the line array (B. Pasewark) using ONR/NRL base funding. This project has been studying the temporal variability of the horizontal line array gain with the objective of relating its variability to fluid dynamic perturbation of the sound speed field along the propagation path.

RESULTS

ASIAEX

Vertical Line Array

Large amplitude internal wave packets propagating across an acoustic propagation path will induce sound-speed field variability that reduces the local matched field processor correlation time from 15 min to ~ 2 min.

Horizontal Line Array

Variability in a conventional beamformer output has not yet been directly correlated to the passage of an internal wave through the acoustic propagation path. Short period omni power and array power fluctuate in phase and the fluctuation statistics appear to change as the statistics of the temperature field change. Array gain performance degradation is influenced by signal to noise ratios variability that is complicating the data interpretation. Analysis continues.

IMPACT/APPLICATIONS

In the long term, the results of this work will permit the prediction of ASW system performance in a shallow water propagation channels that have sound speed fields properties controlled by tidally related fluid processes.

TRANSITIONS

Presentations to SUBPAC, SUBDEVRON12, ONI and N875. The 6.1 derived knowledge base is being used to understand the causes of acoustic signal and naval system performance variability in the littoral.

RELATED PROJECTS

The ASIAEX program includes a number of ONR supported scientists including members of the Woods Hole Oceanographic Institution, the Naval Postgraduate School, The University of Miami and the University of Maine.

PUBLICATIONS

Referred Articles

Orr, M. H. and Mignerey, P. C., 2003, Nonlinear internal waves in the South China Sea – observation of the conversion of depression internal waves to elevation internal waves, J. Geophys. Res., 108, C3, 3064, 2003. [published, refereed]

Peter C. Mignerey and Marshall H. Orr, "Observations of matched-field auto-correlation time in the South China Sea," IEEE J. Ocean. Engineering. [Submitted July 31, 2003, refereed]

Papers

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Turgut, A., Wolf, S., Pasewark, B., Orr, M., and Lynch, J., 2002, Applications of source localization by waveguide invariant theory during the AsiaEx sea tests, J. Acoust. Soc. Am., 112, pg. 2451A.

Lynch, J., Fredricks, A., Colosi, J., Gawarkiewicz, G. And Newhall, A., Chiu, C. S., Orr, M., 2002, Acoustic Effects Of Environmental Variability In The Swarm, Primer And Asiaex Experiments, NATO Saclant Conference Of Littoral Environmental Variability On Acoustic Predictions And Sonar Performance.

Pasewark, B. H., Wolf, S. N., Orr, M. H., X., Lynch, J. H., 2002, Acoustic Intensity Variability In A Shallow Water Environment, NATO Saclant Conference Of Littoral Environmental Variability On Acoustic Predictions And Sonar Performance

Honors/Awards/Prizes

Fellow Acoustical Society of America (2002)